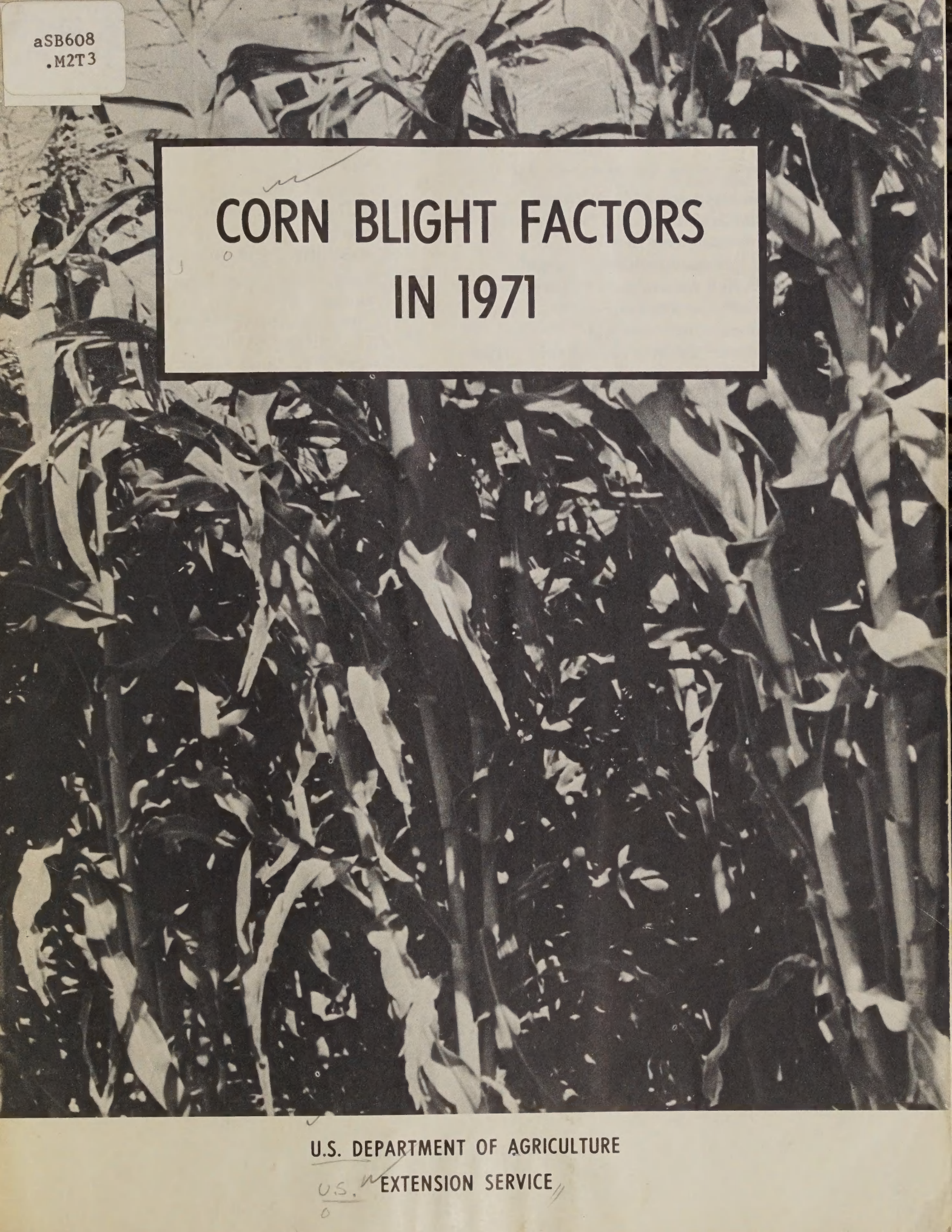


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CORN BLIGHT FACTORS IN 1971

U.S. DEPARTMENT OF AGRICULTURE

U.S. EXTENSION SERVICE

ACKNOWLEDGMENTS

This report was prepared by the USDA Extension Service Task Force on Corn Blight, and reviewed by the USDA Inter-Agency Task Force on Corn Blight.

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FOREWORD

Corn growers in the eastern half of the United States suffered a severe attack of Southern Corn Leaf Blight on their 1970 crop. There is reason to believe a similar attack may occur in 1971, unless certain steps are taken to combat this disease.

Two special committees were established in the Department of Agriculture to help analyze problems resulting from the corn blight attack and to carry out actions that will be helpful to corn growers. One committee is the USDA Inter-Agency Task Force on Corn Blight, and the other is the Extension Service Task Force on Corn Blight.

This publication is a result of the work of these

two task forces. It is based on materials prepared by Extension Service specialists and reviewed by other USDA officials. It is being made available to the farming public through State Extension Services.

Another step in the battle against corn blight is establishment of a National Information Center on Corn Blight in the Department of Agriculture. The staff of this Center consists of a plant pathologist (in charge), an agronomist, an economist, and an information specialist. They and other specialists as assigned will handle inquiries, reports, and releases on the blight situation through 1971.

NED D. BAYLEY, *Director,*
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		WASHINGTON, D.C.	MARCH 1971

CHARACTERISTICS OF SOUTHERN CORN LEAF BLIGHT

ORIGIN AND DISTRIBUTION

Until 1970, Southern Corn Leaf Blight was considered a minor disease. It occurred primarily in the southern States of the United States. The new Race T was identified during 1970 from material that was collected in the Corn Belt in 1969.

The disease first occurred in 1970 during late February and early March in the United States, apparently in the Belle Glade, Fla., area. Disease spores from fields in the Belle Glade area apparently were carried from field to field northward by winds from the South and deposited throughout Florida, southern Georgia, and the coastal areas of Alabama, Mississippi, Louisiana, and Texas.

Between June 13 and July 7, spread of the disease began to form two definite paths. One path moved northward up the Mississippi River and surrounding areas on into southern Minnesota and Wisconsin. The second path moved through coastal areas of Georgia, South Carolina, and North Carolina. By August 28, blight had been reported throughout the eastern part of the United States, and by September 20 it was as far west as north central Kansas. In many areas, corn suffering from lack of soil moisture had severe Southern Corn Leaf Blight. Dew apparently furnishes sufficient moisture for sporulation and infection to occur.

The stage began to be set for the 1970 epidemic of the disease with the discovery that seed corn could be

produced more economically by using the male-sterile technique, in which the male-sterile seed parent rows are grown adjacent to selected pollen-producing rows. The old method required much field labor to hand detassel the seed-producing rows, while the male-sterile technique greatly reduced labor costs and management problems. Too, most plant breeders in the United States have concentrated primarily on one source of male-sterile cytoplasm since 1955. This one source (Texas male-sterile cytoplasm) was in 80 to 90 percent of the hybrid field corn planted by farmers in 1970. T-cytoplasm was widely used because it was superior to any other source for the ability to sterilize under many environments and be restored to fertility.

CAUSE

The disease is incited by the fungal pathogen, *Helminthosporium maydis*. The disease is the damage that results when the fungus invades corn plant tissue.

Two strains (races) of the fungus have been identified from field collections. A distinguishing feature of these two races is the unusually high virulence of one of them on corn containing "T-male-sterile" cytoplasm. This is called race "T". Race "T" is only mildly pathogenic on "normal" or non-male-sterile cytoplasm.

The old race, designated "O", has been known in the United States since 1925 when it was reported from Florida on corn leaves. It has occurred since that time on corn. Recently, studies suggest at least one additional race of the fungus.



Southern corn leaf blight damage to leaf, ear, and stalk.

SYMPTOMS of Race T in the field vary somewhat, depending on the corn hybrid grown, presence of other corn diseases and secondary micro-organisms, amount and distribution of rainfall and dew, as well as other factors. The disease may occur on corn at any stage of growth.

The reduction of functional leaf area by Race T predisposes the corn plant to many other stalk and ear rotting organisms. Lodging is severe in heavily infested fields. Early infection of the corn may result in improperly filled ears. Later infection may result in small kernels with low test weight. Ear tip infection may seal or paste the husks to the grain, making husking, shelling, and separating more difficult.

Cob rot reduces cob strength, presenting problems in shelling, separating and cleaning. Black spores may be produced profusely on the kernels and cob. Infected ears break up more readily in the harvesting machinery. In severe cases, corn fields may look as if

an early frost or freeze had occurred 12 to 14 days after initial infection.

In most situations, because of the presence of other diseases, a laboratory diagnosis is necessary for positive identification. For a full description of other diseases, see USDA Agriculture Handbook No. 199, *Corn Diseases in the United States and Their Control*.

Corn harvested from damaged fields may be more vulnerable to storage rot diseases.

EPIDEMIOLOGY

The epidemic of Southern Corn Leaf Blight in 1970 developed because of these factors: (1) the presence of abundant inoculum (spores) of a virulent pathogen (Race T) early in the season, (2) a concentrated and extensive homogeneous population of a susceptible host (corn with male-sterile cytoplasm), (3) abundant and timely widespread liberation of inoculum into the wind currents in the southern States and (4) favor-

able weather conditions—moisture and temperature—for rapid and abundant spore germination, infection, and reinfection by the pathogen.

Widespread drought in the western regions of the Corn Belt restricted development of the blight. Late planting of corn encouraged development in many areas. The fungus is favored by rainy weather, high humidity, dews, and temperature ranging from 55 to 80 degrees. Severe infections may occur where overhead irrigation is practiced and where there are heavy dews. High plant populations per acre may dry slower from dews and rains as compared with thinly spaced plants and thereby enhance infection. The fungus spores are believed to be wind blown for many miles. Rain spreads the spores by splashing.

INFECTION CYCLE AND OVERWINTERING

The pathogen may complete its infection cycle in 60 hours. A film of moisture on a leaf surface for 6 to 8 hours is sufficient for germination and infection to take place.

Primary infections generally occur on the lower leaves, and the fungus spores are spread to the upper younger leaves by wind or splashing rain. The fungus can penetrate the husk in 2 weeks or less. It may enter the ear at the open end near the silks. The fungus is believed to overwinter on corn plant residues left in the fields or in cribs after harvesting. The pathogen appears to be much more virulent when spreading from other green leaves than from its overwintering source (corn debris).

POTENTIAL FOR LEAF BLIGHT (RACE T) IN 1971

There seems to be no doubt that the essential factors for blight exist for 1971. The big question is how much, when and where. Inoculum is already present in Florida on the winter crop. In spite of all best efforts, there will be several millions of acres of susceptible corn grown in 1971.

Fortunately, much of the acreage in the deep South and part of that of the Mid-South will be planted with resistant or partially resistant seed. This should moderate the volume of spores produced and blown northward to the Corn Belt where proportionally larger acreages will be seeded to blends and to T-cytoplasm hybrids.

The big unknown is the weather. Cool dry weather in the South early in the season will reduce inoculum potential and likelihood of an epidemic later in the season. The same kind of weather in the Corn Belt later in the season will also have a depressing effect on the disease. Hot, moist weather will have an opposite effect on disease buildup. Since weather that is optimum for growing corn is also suitable for corn blight, it appears that at least some blight can be expected in 1971. The role of overwintering inoculum is largely unknown, but many scientists believe that this source of infection will be secondary in importance to windblown spores from the South.

Here are some factors for a grower to consider when attempting to predict probable occurrence of disease (Race T) in 1971 in his fields.

● HYBRID TO BE GROWN

Degree of resistance or susceptibility should be determined from grower observation, from seed company, or local Extension sources. Other conditions being the same, more blight is apt to occur with susceptible hybrids. This is *most important* factor in determining potential for blight.

● SITE OF FIELD

Fields with better air drainage tend to have less blight. River bottom lands tend to have dews more

frequent, heavier, and longer lasting providing conditions for more infections.

● OCCURRENCE IN 1970

Where disease was severe in 1970 it is apt to be serious again in 1971 (given same conditions such as susceptible hybrid, weather, etc.). However, disease can be serious in those areas where the disease did not occur in 1970 if favorable weather occurs, susceptible hybrids are grown, etc.

● DATE OF PLANTING

In many areas early planted corn escaped severe damage in 1970, but there were exceptions. Check with local Extension sources.

● RATE OF PLANTING

High rates of planting may result in thicker stands of corn that tend to dry out more slowly following dews or rain. Thus, somewhat more blight may occur with heavier seeding rates. Confer with local authorities on suggested seeding rates.

● WEED AND GRASS CONTROL

Weeds and grass slow drying following rain or dew, making conditions more favorable to blight.

● AIR POLLUTION, STAGNANT AIR MASSES, AND CLOUDINESS

These may also prevent drying of corn plants after rain and dew, increasing possibility of infections.

● PRESENCE OF PROTECTANT FUNGICIDES ON CORN PLANTS

Sweet corn, seed corn, and research fields may be protected with fungicides and thus escape serious damage. Costs of spraying may be prohibitive for most field corn producers unless there is an effective warning system, and if only a limited number of applications will be needed (in cases of very late infections).

● TYPE OF IRRIGATION

Sprinkler overhead systems are more conducive to blight than furrow irrigation. Irrigation should be planned so that foliage dries off well before nightfall.

SEED SELECTION TO REDUCE CORN BLIGHT HAZARD IN 1971

Seed selection is the key to producing corn under blight conditions.

Sound seed of adapted varieties with required tolerance is a prime concern. Should blight prove to be of little importance next season, the problem is solved. But, with a repetition of the 1970 epidemic, the tolerance of the seed used will make a substantial difference. The distribution of the disease in 1970 is the most realistic blight pattern to prepare for in 1971.

There are five kinds of seed to consider. The strong and weak points of each are outlined below.

- **NORMAL CYTOPLASM HYBRIDS
(N-SEED)**

Seed of these hybrids is generally produced *without* the use of Texas male-sterile cytoplasm, most of it by detasseling. Total supplies expected will meet about one-sixth of the 1971 national needs.

The advantage of N-seed is that the crop is generally tolerant to prevailing strains of the leaf blight. It can be expected to produce normal yields. Disadvantages are: The seed supply is low in comparison to demand and largely committed, and the cost is relatively high.

- **BLENDS (B-SEED)**

Blends are combinations of the same hybrid, one portion of which involves normal or N-cytoplasm and the remainder, Texas male-sterile or T-cytoplasm. Blends differ in their levels of resistance. Their value under heavy infection tends to agree with the proportion of tolerant to susceptible (N to T) seed.

Blends' advantages include lower cost and the prospect that, in the absence of blight, one could expect slight if any difference in yield when compared to N-cytoplasm seed. For years, in fact, blends have accounted for a large share of our hybrid seed.

The disadvantages of blends pivot largely on whether blight occurs, its intensity, and the stage of the crop upon exposure. If blight is serious, results expected healthy stalks causing harvest and storage problems. Under light or late infection these differences may be minor.

- **TEXAS MALE-STERILE (TMS) CYTOPLASM (T-SEED)**

In blight-free areas, or those where infection is light or late in appearing, use of adapted T-hybrids

should cause no serious problem. But, where infection occurs on the scale and schedule of 1970, similar destruction is to be expected. Hence, the odds in using T-hybrids appear most favorable in areas isolated from the region afflicted by Southern Corn Leaf Blight in 1970.

An added consideration is that some hybrids produced with T-cytoplasm show a measure of tolerance. The farmer should depend upon his own observations, his seed dealer, and his county agent for comparative results of field studies under blight conditions.

- ***Second Generation (F_2) Seed of Blight-Tolerant Hybrids***

Seed of this type is relatively inexpensive and, if drawn from a crop that resisted corn blight in 1970, can reasonably be expected to offer resistance in 1971. Major disadvantages of F_2 seed include lack of assurance that the parent crop definitely was resistant to blight in 1970, and a drop in productivity from the parent crop due to loss of hybrid vigor approximately as follows:

Double or four-way crosses (4x)	20
Three-way crosses (3x)	25
Single crosses (2x)	30

Other disadvantages are difficulty of knowing the parentage and number of parent lines involved, and the problem of cleaning, grading, and treating seed to insure uniform stands.

- ***Blight-Tolerant Open-Pollinated Varieties***

Open-pollinated seed denies a farmer the advantages of hybrid vigor along with the benefit of recent advancements in corn breeding. Nor are all open-pollinated varieties blight-tolerant. Good seed of high-yielding varieties is scarce.

SEED CORN SITUATION

"If farmers plant only the same corn acreage as in 1970 and use the same amounts of the various hybrid varieties they did last year, there will be enough *total* seed for the 1971 crop. But there will not be seed enough of resistant varieties for everyone." Thus, D. D. Walker, president of the American Seed Trade Association summed up the 1971 seed corn situation at a meeting of major seed corn producers with Secretary Hardin, other USDA officials, and the USDA Corn Blight Task Force.

The seed supply in sight breaks down as to adaptation and blight reaction as shown in Table 1 on page 6.

Some encouraging considerations include the discovery of unexpected resistance in some blends and even T-hybrids. There is inducement here to reexamine 1970 variety test results. Beyond these factors is the concern of seedsmen, while building up their stocks of resistant varieties, to shift existing seed, within their

ranges of varietal adaptation, in the direction where they are expected to serve overall interests best. These shifts are reflected in the table.

The table reflects available seed supplies in terms of acres to be covered, by types of seed and by regions of adaptation.

Table 1.—EXPECTED 1971 SEED CORN SUPPLY ¹
FEBRUARY 5, 1971

Region	Seeding rate	N seed ²		B seed ²		T seed ³		Total reported seed	1971 acreage (possible)	Percent of 1970 acreage	Total 1970 acreage
		Acres	Percent of 1970 acreage	Acres	Percent of 1970 acreage	Acres	Percent of 1970 acreage				
	<i>Pounds/acre</i>	<i>(Thousands)</i>		<i>(Thousands)</i>		<i>(Thousands)</i>		<i>(Thousand pounds)</i>	<i>(Thousands)</i>		<i>(Thousands)</i>
Deep South.....	10	1, 917	47. 6	442	10. 9	459	11. 1	29, 923	2, 818	69. 6	4, 031
Mid-South.....	10	2, 380	30. 8	4, 465	57. 8	1, 561	20. 2	89, 396	8, 406	109. 0	7, 724
East.....	14	363	14. 8	1, 334	54. 3	744	30. 3	36, 577	2, 441	99. 4	2, 454
Eastern and Central Corn Belt....	13	7, 099	27. 2	11, 412	43. 4	7, 118	27. 3	355, 999	25, 629	97. 9	26, 074
Western Corn Belt.....	12	905	6. 4	3, 721	26. 2	9, 310	65. 6	180, 625	13, 936	98. 2	14, 184
Northern States.....	12	2, 246	21. 6	2, 920	28. 1	5, 228	50. 0	136, 011	10, 394	99. 7	10, 394
Total.....		14, 910		24, 294		24, 420		828, 531	63, 624		64, 861

¹ Reporting companies were estimated to have supplied 80 percent of the seed sold in 1970. It is assumed that the unreported seed is mostly of T-cytoplasm.

² 5 percent seed deducted for pipeline.

³ 10 percent seed deducted for pipeline.

⁴ For those States included in the seed corn survey.

OTHER METHODS TO REDUCE RISK

FEDERAL CROP INSURANCE

All-risk crop insurance for corn is offered by the Federal Crop Insurance Corporation. It provides corn farmers insurance of all or a major part of their annual production costs against loss from unavoidable causes. Insured are all unavoidable losses due to adverse weather conditions, fire, flood, insect infestation, wildlife, and plant disease. "Plant disease," of course, includes corn blight. Federal crop insurance does not cover loss due to neglect, malfeasance, or failure to follow good farming practices. "Annual production costs" are based on the usual production practices and cost rates in the area. They include labor, taxes on the land, and 6 percent of the value of the land at usual values per acre in the area. For the 1971 crop year, the corporation will provide insurance on corn in 582 counties in 26 States. These include seven new counties in Kansas and Nebraska.

In each of the 575 counties with Federal crop insurance on corn in 1970, a liability limit for 1971 has been set at 150 percent of 1970 corn crop protection. For the 575 counties, total coverage in 1971 cannot exceed \$225 million. This compares with \$150 million in 1970. Current FCIC policyholders, whose contracts continue from year to year, will not be affected by these limitations if they continue their contracts in force.

Protection is provided on an insurance-unit basis. The bushels guaranteed on the unit are determined by the acres insured and the bushel guarantee per acre established for the acreage. The farmer selects in advance the price per bushel at which his loss will be paid.

Production is adjusted for the moisture and test weight, and in the case of ear corn, for the shelling percentage in determining loss.

The premium rates vary among areas, depending on the risks and insuring experience. Guarantees vary on the basis of both past production history and loss experience. Premium rates for 1971 will not be increased because of corn blight.

The local Extension office will know whether Federal crop insurance on corn is available in a specific county.

PRIVATE AND MUTUAL INSURANCE

In recent years, some private and mutual insurance companies have operated experimental all-risk crop insurance programs in some areas in Indiana, Illinois, and Iowa. Corn crops have been insured in these ex-

perimental programs. It seems doubtful that these programs will be expanded substantially in 1971.

CULTURAL PRACTICES FOR CORN UNDER BLIGHT CONDITIONS

Once a grower decides to plant corn in 1971, he should carry out the practices most likely to insure success. They are described below.

MEASURE SOIL FERTILITY. He should make sure the fertility of the soil is such that plants will not be placed under abnormal stress. Have soil samples tested early.

CHECK ACIDITY. Corn will tolerate some acidity, but 1971 is a good time to lime acid soils.

DON'T PANIC. The grower should stick to the method he has found best. This year is a poor time to take a gamble on a long shot or to shift to a new method.

GRAIN PLANTING DATES.—The date of planting will depend on the severity of blight expected and the kind of seed available. Outside the blight area, there is little cause to change. Probably most of the seed available will be susceptible, whether blends or T-cytoplasm seed. The odds favor planting the T-cytoplasm on the early side, and the blended seed at the ideal date for corn planting. Normal cytoplasm seed and blended seed are in such short supply that farmers who fail to get a stand will probably have to depend on T-cytoplasm seed for replanting.

Farmers in the area where blight may be expected in 1971 should follow the same pattern. Corn produced for grain should have first claim on the normal cytoplasm seed and be planted when soil conditions and weather are best for corn. If normal cytoplasm seed is lacking, blends are the next choice. The grower who has T-cytoplasm seed and some other sort would do well to plant the T-cytoplasm seed first.

In high-risk areas, such as river bottom subject to overflow and lowlands subject to late frosts and freezes, it would be well to delay planting until the danger has passed.

In corn belt areas where blends and normal seed are scarce, it appears advisable to plant corn on the early side of the normal date. Plant the best seed at the best possible time.

GERMINATION.—Ordinarily, with seed germinating 95 percent or better, about 10 percent more seeds are required than the intended stand. With 90-percent seed, 15 to 18 percent more kernels should be planted, and with 85-percent germination, rates should

be increased 20 to 25 percent. It is difficult to estimate stands from seed of lower germination. Vitality of such seed is usually weak. The above calculations are for plow-and-plant methods. If minimum tillage is to be used, the rate of planting may need to be increased from 1,000 to 2,000 extra kernels per acre to obtain desired stands.

To produce quality grain in 1971, crowded stands should be avoided. In determining the rate of planting, two points to be kept in mind are: (1) Any abnormal soil conditions which affect stands, such as heavy soils, with a tendency to run together. The same is true for muck and peat soils. (2) The normal moisture supply. Either too little or too much moisture influences the ability of land to produce corn. Early planting calls for slightly heavier rates than normal.

PLANTING DEPTH.—Early in the season, shallow-planted corn has the advantage. One-inch depth is considered shallow, and 3 inches, rather deep. If the early planting is shallow, the seed germinates more rapidly because the surface soil warms first. Corn germinates slowly until the temperature reaches 60° F.

PLANTING RATES.—Planting rates should be geared to maximum yield under normal conditions. To be recognized is the recent tendency among corn growers to increase planting rates beyond the productivity of the soil. It requires only 130 to 150 stalks to make a bushel of corn. The average of 140 stalks with an average of one-half pound of ear weight per stalk make 70 pounds, the normal weight per bushel.

Random samples from 1970 corn fields showed that in the North Central States the average stands approximated 17,100 stalks per acre. In the South Atlantic (Virginia, North Carolina, South Carolina, and Georgia) 13,300; and in South Central (Kentucky, Tennessee, Alabama, Mississippi, and Texas) 12,000 stalks per acre. These populations are sufficient for average yields of 122 bushels in the North Central States, 95 bushels in the South Central States, and 85 bushels in the South Atlantic States. It appears that these rates are higher than necessary to obtain the yields reported, and considerably higher in the South. Planters should be adjusted to plant the number of

kernels required to produce about 140 stalks per bushel of corn that the soil will normally produce. Hence, 100-bushel land should have about 14,000 plants per acre at harvest. This practice may require adjustment of the planter for different fields. Adjusting planting rates to productivity of the soil should not only stretch seed supplies but also reduce stress on the growing crop.

PLANTING METHOD.—In areas where corn blight is expected and highly resistant seed is not available, growing a combination of crops deserves consideration. For example, the farmer growing corn and soybeans may gain some advantage by planting these crops in alternate strips of two, four, or six rows. The strips should be arranged in such fashion that each crop can be cultivated and harvested with the equipment available. The advantage to the corn crop is that air movement keeps the leaves drier. If planted two rows of corn and two rows of soybeans, every corn row is an outside row. The sunlight speeds drying of the leaves which are usually affected first by blight. This treatment would be satisfactory in much of the southern and central corn-producing areas.

The disadvantage lies in fertilizing and weed control. Some of the chemicals used on corn are not compatible with soybeans. If the farmer applies nitrogen to the corn he may not realize the expected profitable return and the nitrogen will do little for the soybeans; it may increase the weed problem. As normally managed, corn aids in weed control. But, when grown in narrow strips, weeds may demand special attention. In dry areas subject to hot, dry winds, loss of moisture from the plant may be excessive.

WEED CONTROL.—There are two reasons to keep the corn field free from weeds in any blight area. Weeds compete with the corn for moisture and plant food and in some cases sunlight, and weedy fields do not dry out rapidly following rain or irrigation. Even dews keep the lower corn leaves moist, noticeably longer in weedy fields than in weed-free fields. This condition favors the spread of blight. This is the year to make an extra effort to control weeds. As planting rates are reduced, weeds are likely to be more prevalent.



Grass and weeds tend to hold moisture and thus increase corn blight damage.

SPRAYING

Check with local agricultural authorities regarding current fungicide usage. Usefulness of fungicides depends on early and thorough coverage of the plants. They only prevent new infections from occurring and do not eradicate earlier disease infections. Since repeated applications will be necessary and are relatively expensive, the decision to apply them must be made carefully, taking into account the following considerations:

- Potential yield and value of the crop;
- Availability of a satisfactory means of application;
- Stage of plant development;
- Weather pattern;
- Present disease situation in the field;
- Susceptibility of the crop;
- Planned use of the crop;
- Probability of incoming windblown spores.

APPLICATION METHODS.—Two methods—Hi-boy and aerial—may be used. If Hi-boy is used, apply about 40 gallons of spray per acre with a minimum of 150 pounds of pressure. Four hollow cone-type drop nozzles, two on either side spaced and directed to cover the ears and upper foliage, are necessary to obtain adequate coverage. A fifth nozzle above the row may be needed. If high pressure is not available, better coverage may be obtained by increasing the gallonage per acre and adding sufficient spreader-sticker.

Aerial application is easier, faster, and more operable in wet weather, but will probably not control the disease as well. Only airplanes or helicopters properly equipped for fungicide application should be used. (Some aircraft may be equipped for spraying only insecticides or herbicides.) Primary question of aerial application relates to ear and shank protection. Six gallons of water containing the recommended amount of fungicide plus spreader-sticker per acre should be used. (Many operators use only 2 to 3 gallons of water per acre.)

Spraying should not be done if there is an immediate threat of rain. The chemical should have time to dry on the plants to resist washoff. If good coverage is obtained, the treatment should last from 10 to 14 days (on fully grown crop) in drier weather. In rainy periods, treatment interval should be reduced to 7 days.

COSTS.—Some authorities indicate that, under conditions highly favorable for blight development and plant growth, it may be necessary to spray every 3 days and possibly stretched to as much as 10-day frequency under dry weather conditions. Therefore, it is difficult to estimate costs of spray treatment.

HARVESTING PRACTICES

INSPECT THE FIELD.—At regular intervals farmers should observe their fields closely for blight. If it is present, estimate the rate of development to decide on future action. Observations should be made within the field away from the outside rows. Outside rows develop and dry differently because of their access to light and air.

To check on stalk rot, pinch stalks near the ground and up toward the ear.

A hollow shell that collapses easily indicates advanced rot.

Pull ears that are representative of the different field conditions and flex, twist, and break cobs to look for rot. Squeeze the ears to test crushing strength, which will help indicate when to start the harvest to minimize losses. Note dropped ears and shake stalks to estimate shank rot and ear drop.

Stalk rot and cob rot in heavily blighted corn are generally severe and develop exceptionally fast. Lodging is potentially very severe. Many stalks may break off before or during harvesting, causing excessive loss and clogging.

Stalk and cob rots are also present in the ear shank; thus, ears in some fields will drop readily before or during harvest. The cob rots also destroy the central core of the cob. In advanced cases, cobs are spongy or rubbery when twisted or flexed, and can be easily crushed by squeezing. The rotted cob will not withstand the pressure necessary for shelling.

Secondary ear molds may also appear on the corn kernels and exposed cob surfaces. These molds will tend to stabilize and stop growing when kernel moisture content reaches 21 to 25 percent in the field. Cob moisture content can be higher when the kernels have dried to this level.

The first and most specific recommendation on harvesting "down" corn is to *slow down*. A ground speed of 2 miles per hour is usually about right. Gathering chain speeds and roll velocity should be correspondingly reduced to maintain the normal relationship with ground speed. Snapping should occur about one-third of the roll from the top.

PLANT AND HARVEST EARLY.—This is the key to beating the corn blight. Early harvest is the best general recommendation if the problems of handling and storing such corn can be met.

SAFETY WITH MACHINERY.—Field conditions with blight will present many machine clogging and shelling problems in rotted "down" corn. Harvest may

require longer, more tedious hours that will mean frustration and extra fatigue. Machine operators should think about man-machine practices and recognize the added dangers.

STORAGE METHODS

Both *corn silage* and high-moisture shelled corn or corn-and-cob meal can apparently be made satisfactorily from blighted corn. The limitation is in ensiling materials that are in advanced stage of decomposition in the field.

Either shelled corn or corn and cob meal can be ensiled alone. Moisture content ideally would be in the 22 to 25 percent range, especially for shelled corn for hogs. Moisture content can run up to 30 percent or more if necessary to salvage the material.

The safest storage for *dry grain* is probably shelled corn dried uniformly to 12 to 13 percent and maintained at this moisture content. Mold organisms will generally be inactive at these moisture contents. The lower than normal (13 to 14 percent) recommended moisture content will help offset problems from increased fines, residue from rotted kernels, chaffy grains, etc. Shelling of infected corn should not be done during the growing season to avoid spreading of spores.

EAR CORN STORAGE.—This method is somewhat difficult to assess. The mold development on the ear standing in the field will slow or stop when moisture contents reach the 25 to 21 percent range. However, if ear corn is then harvested and cribbed, molds will continue to grow in storage at the higher moistures of this range until freezing temperatures occur. A kernel moisture of 18 percent should stop growth of corn blight mold and almost all storage molds.

SHELLED CORN STORAGE.—More fines, trash, and residue for moldy and rotten grain means more risky storage. Grain that is excessively damaged or chaffy should not be considered for any appreciable storage period if it is not essential. Shelled grain is a living product that is subject to biological/chemical changes if not managed correctly. Good grain under correct management can be stored for years and hold quality, but grain of initially poor quality will require superior management to maintain even short term satisfactory storage. The risk is simply greater than it would be under normal conditions.

No storage problem is expected from the mold activity of *H. maydis* at dry grain moisture content low enough for long-term storage, since the mold will be dormant at these conditions.

At one-tenth cubic foot per minute per bushel, which is typical for most on-farm dry grain aeration systems, it normally takes 100 to 160 or more hours of continuous fan operation to bring about a temperature change throughout the entire grain mass. Any time the outside air averages 10° or more below the average temperature of the grain in the bin, consider running the fan.

Once the grain is cold (30° to 40° F.), it is not generally necessary to run the fan, except for very short periods to check the exhaust for possible odors indicating spoilage. Don't freeze grain by running the fan in extremely cold weather. Grain sweats when it is unloaded on warm days, and can result in frozen chunks of grain in the bin if moist air is blown into the bin in the spring.

CONDITIONING CORN

All of the commonly used methods of *drying grain*, involving both bin and flow-through methods should work satisfactorily in the grain conditions from blighted corn. The grain will contain more fines, more trash, more rotten and moldy kernel refuse, and a higher initial moisture content. This means, in general, that it will not flow as readily or well, will impede air flow, will not look or grade as well before or after drying, and will probably take longer to dry each bushel. Remember, however, that you may have fewer bushels to dry, and may be drying them earlier in the season with more favorable drying conditions to start with.

Grain cleaning on both the input and output side of the drying process might be considered when excessive fines are evident. Wet side cleaning never works well. The fine materials do not separate easily or completely. The wet fines present problems in storage and handling unless they can be fed immediately. Such input cleaning probably has more advantages in a deep layer bin drying process, since the grain is not removed for storage.

Cleaning on the output side of the dryer, before the grain goes to final storage, is advisable only where fines are excessive.

For *in-bin drying* processes, the use of shallower

grain depths should be considered. This will help compensate for higher initial moistures and more fines, which reduce air flow. Even distribution of fines into the bin will be even more important than normal. The addition of grain stirring equipment, especially where the existing bin is too small to give adequate drying capacity even under good conditions, may be an especially wise decision.

Reduced air flow, increased moisture content, and flow problems are potential problems in *flow-through* dryers. Poor flow can result in a pocket of grain or refuse material "hanging up" in the dryer and ultimately causing trouble. Such nonflow can be checked in batch dryers, since they unload frequently, but continuous flow units may not be cleared except at the end of the season. Since continued nonflow and/or refuse accumulation in an area of the dryer can increase the likelihood of fire, the dryer should be inspected carefully, the interval depending on past history and the operating conditions at the moment.

HEALTH HAZARDS

Many questions and rumors have been raised about the dangers of inhaling the heavy black dust during harvesting of blighted corn. It has not been possible to document a case of serious illness from such dust.

However, some persons who have been exposed to the dust have experienced respiratory discomfort.

Samples of the dust have been analyzed and determined to contain many types of mold organisms including *H. maydis* spores along with considerable dirt and plant residues. There appears to be no particular danger to people or animals, either from inhalation or consumption of the mold organism *H. maydis*, but caution is advised.

Dust inhalation can apparently give some people a "dust cold," with flulike symptoms. A breathing mask with a replaceable or washable filter is advised.

The use of closed, filtered air-circulation systems on the harvest machine cab may also be desirable. Since the earlier harvest period for blighted corn may mean operation in hot weather, air conditioning may be necessary if dust is to be excluded from the cab.

ALTERNATIVE CROPS

Farmers who experienced an attack of Southern Corn Leaf Blight on corn fields in 1970, or are threatened by a possible attack in 1971, may want to consider growing other crops.

Other alternatives may be lower planting rates of hybrid seed and use of F_2 (second-generation) seed corn.

Soybeans are the best crop alternatives for most of the blight region. Grain sorghum and spring oats may be alternatives in some areas. For the cattle or sheep producer, corn or sorghum for silage may be a good alternative to corn for grain.

It may also be profitable to grow soybeans for sale and buy back corn, wheat, or other grains to feed livestock.

Assuming that no new, more virulent races develop, the Southern Corn Leaf Blight threat is likely to be of short duration (1 or 2 years). Therefore, alterna-

tive crops will not warrant large-scale changes in machinery systems or livestock programs.

Farmers will want to calculate the relative profitability of other crops compared with corn by estimating return above variable costs for corn and other crops. They can calculate variable costs for each crop, using the worksheet on page 13 as a guide.

In many Corn Belt areas, corn and corn silage compete favorably with alternative crops even when corn yields are reduced 10 to 25 percent. The example shown in table 2 shows that at a yield of 78 bushels per acre (25 percent below normal) and a price of \$1.50 per bushel, corn will return \$71 per acre above variable cost as compared to \$66 for soybeans at a price of \$3 per bushel. If soybean prices are reduced relative to corn prices, corn becomes even more competitive.

Farmers can set up their own tables of prices and yields and select a level of yield and price for each alternative crop that will fit the situation in 1971.

WORKSHEET TO FIGURE VARIABLE COSTS

Crop _____ Yield Per Planted Acre _____ Location _____

Category	Unit	Quantity	Price (dollars)	Cost (dollars)
Preharvest costs:				
Labor (operator, family, and hired)	Hour			
Seed	Pound			
Fertilizer and lime:				
Nitrogen (N)	Pound			
Phosphorus (P)	Pound			
Potassium (K)	Pound			
Lime	Ton			
Power and equipment:				
Fuel, lubricant, and repairs	Gallon, etc.			
Insecticides:				
Materials (various)	Pound or gallon			
Herbicides:				
Materials (various)	Pound or gallon			
Custom hire:				
Fertilizer application	Acre			
Insecticide and herbicide application	Acre			
Other custom work	Acre			
Other expenses:				
Crop hail insurance	Acre			
Interest on operating expenses:				
_____ months at _____ percent	Percent			
Total preharvest cost per acre				
Harvest costs:				
Labor (operator, family, and hired)	Hour			
Power and equipment:				
Fuel, lubricant, and repairs	Gallon, etc.			
Custom hire:				
Harvesting	Acre			
Drying	Bushel			
Trucking	Bushel			
Other expenses:				
Drying	Bushel			
Storage	Bushel			
Total harvest cost per planted acre				
Total variable cost per planted acre				

Table 2.—RETURNS ABOVE VARIABLE COSTS PER ACRE FOR ALTERNATIVE CROPS AT SEVERAL PRICE LEVELS

Crop and yield per acre	Value per unit	Total value ¹	Variable costs ²	Return above variable costs ¹
Corn for grain:				
Normal yield (104 bushels).....	\$1. 05	\$109	\$49	\$60
	1. 20	125	49	76
	1. 35	140	49	91
	1. 50	156	49	107
10 percent reduction (94 bushels).....	1. 05	99	48	51
	1. 20	113	48	65
	1. 35	127	48	79
	1. 50	141	48	93
25 percent reduction (78 bushels).....	1. 05	82	46	36
	1. 20	94	46	48
	1. 35	105	46	59
	1. 50	117	46	71
50 percent reduction (52 bushels).....	1. 05	55	44	11
	1. 20	62	44	18
	1. 35	70	44	26
	1. 50	78	44	34
Corn silage:				
Normal yield, 16.1 tons.....	8. 00	129	56	73
10 percent reduction, 14.5 tons.....	8. 00	116	54	62
20 percent reduction, 12.9 tons.....	8. 00	103	52	51
Soybeans:				
30 bushels.....	2. 25	68	24	44
	2. 50	75	24	51
	2. 75	83	24	59
	3. 00	90	24	66
Oats:				
66 bushels.....	. 60	40	13	27
	. 70	46	13	33
	. 80	53	13	40
	. 90	59	13	46
Farm program—Set-aside (corn).....	(³)	83	4	79

¹ To nearest dollar.

² Variable costs include labor, seed, fertilizer, lime, fuel, lubricants, repairs, insecticides, herbicides, custom mach. hire, insurance, interest on operating expense, drying, trucking, and

storage. Adapted from ERS data.

³ Assumes no conserving base; 20 percent set-aside rate; and payment rate of \$0.32 per bushel on 50 percent of base.

Farmers have another alternative—participation in the Government feed grain program. They can compare possible returns from corn and other crops with the return from acreage idled under the Government feed grain program. They will need to calculate the return per acre idled. Below is a formula to calculate return per acre above variable costs for participation in the feed grain program.

$$\frac{\text{Total Government program payment (feed grain)}}{\text{Acres of land idled by participation in feed grain portion of Government program}} = \frac{\text{Total amount received per acre idled} - \text{Variable costs for maintenance}}{\text{Return per acre above variable costs}}$$

An example:

$$\frac{100 \text{ acres} \times 104 \text{ bushels per acre} \times \$0.32 \text{ per bushel}}{40 \text{ acres idled}} = \$83^3 - \$4 = \$79$$

(The above calculations are based upon a 200-acre feed grain base and a “program yield” of 104 bushels per acre.)

¹ Could include both set-aside acres and conserving base acres, but only set-aside is considered in this example.

² Part of this land may be used to produce hay which could be stored for use only in an emergency declared by the Sec-

In the following example, the payment rate is \$0.32 per bushel of yield based upon 20 percent set-aside. (Yields for calculating payments will be based upon 1970 “program” yields.) If the final set-aside rate is less than 20 percent, the payment rate would be reduced proportionately.

retary of Agriculture. To do this, the farmer must agree in writing to stipulations in section 805 of the Agricultural Act of 1970.

³ To nearest dollar.

Numerous other alternatives are possible under the 1971 feed grain program. Farmers should contact their

local ASCS and Extension offices for complete details on the program.

FEED CONSIDERATIONS FEEDING BLIGHT-DAMAGED CORN TO LIVESTOCK

Many cases of livestock poisoning in the United States have been attributed to feeds infested with toxic fungi. As soon as scientists could obtain forage and grain contaminated with *Helminthosporium maydis*, the fungus causing Southern Corn Leaf Blight, they began feeding it to a wide array of animal species to determine if it is toxic. Extensive trials with feedstuffs contaminated with this fungus have not resulted in mycotoxicoses—diseases resulting from the ingestion of feeds which contain mold-produced toxins.

There is a wide variation in the amount and nature of blight-caused damage to the feed value of corn. This variation complicates the problem of making recommendations about feeding such corn. However, palatability problems have been minimal, and rates of gain and feed efficiency have not been significantly different from those obtained with corn forage and grain not affected by blight. Animal production per acre has been drastically reduced in many areas because of poor yields, but grain and forage salvaged from blight-damaged fields have been feeding much better than expected.

Although the fungus causing corn blight does not appear to be toxic, and blight-infested corn seems to be feeding well, there is still another problem. Grain damaged by Southern Corn Leaf Blight is susceptible to invasion by secondary molds. Some of these molds may produce metabolites harmful to livestock. Livestock producers had problems with mycotoxicoses even before the widespread damage from this blight improved growing conditions for other molds. Secondary molds could become a serious problem.

More than 200 toxic metabolites (mycotoxins) generated by molds can cause mycotoxicoses in livestock. Exposure of livestock to mycotoxins can result in a variety of disorders including vulvovaginitis, anorexia, diarrhea, prostration, and even death. For example, there is some evidence that isolates of *Fusarium graminearum* are capable of producing a strongly estrogenic compound, designated F₂. It has been demonstrated that the F₂ strain produced by the fungus in naturally infested corn may be chiefly responsible for the estrogenic syndrome in swine. The presence or absence of a known toxic producing fungus in a suspect sample of feed at a given time has little or no relation to the presence of the toxin or toxins produced by that fungus. The problem is complicated further

because the production of toxins resulting in mycotoxicoses is influenced by many factors such as:

- The strain or isolate of the fungus;
- The substrate on which the fungus grows;
- Temperatures at which it grows;
- Other microflora associated with it;
- Species of animals to which it is fed (and possibly even the individual animal or a given species).

The exact prevalence of mycotoxins in various feedstuffs is not known. There are strong indications that they may be relatively common. Some mycotoxins, such as aflatoxin, patulin, and islandotoxin have been demonstrated to be carcinogens. This emphasizes the potential seriousness of the mycotoxin problem and the possible effect it may have on present and future animal agriculture. This problem is now accentuated by the advent of Southern Corn Leaf Blight, which is providing excellent conditions for secondary molds to develop. However, the degree to which these molds may develop and produce toxins as a result of Southern Corn Leaf Blight is unknown.

Although specific problems associated with the feeding of blight-infested corn have not appeared, producers should exercise special caution when feeding blight-damaged corn to young and pregnant animals because they appear to be the most vulnerable to mycotoxins. Producers should also be advised against the practice of forcing animals to eat moldy or rotten corn to avoid toxicity from molds.

EFFECTS OF BLIGHT-DAMAGED CORN WHEN FED TO POULTRY

Corn damaged by the Southern Corn Leaf Blight seems to have less nutritional value, but the fungus itself does not seem toxic to chickens.

The greatest danger from blighted corn appears to be from secondary invasion by molds during storage of high-moisture corn. Storage molds such as *Aspergillus* may infect the corn after harvest. Some strains of these molds produce toxins harmful to poultry.

Aspergillosis (brooder pneumonia) caused by mold spores growing in the bird's respiratory tract produce a serious problem. This mold, *Aspergillus fumigatus*, can be found in moldy litter and apparently is widespread in nature. The mycotoxins or poisons are formed during the growth of various molds.

Aspergillus flavus produces, under the right conditions, "aflatoxin." Aflatoxins affect the nervous system and produce paralysis, convulsions, and death. In

certain cases they produce enteritis, which if improperly diagnosed as Coccidiosis and treated as such may result in a critical condition. Damage from molds or aflatoxins may develop slowly and may weaken chickens by reducing the white blood cell count or by causing a nutritional deficiency.

The effects of aflatoxin in poultry can be partially overcome by increasing the protein level and the fat content of the ration. Such increases have been shown to improve feed efficiency and reduce mortality. Mold

inhibitors added to the feed at a rate of 3 to 10 pounds per ton may help to overcome this potential problem. It will not destroy molds already present in the ingredients.

Corn damaged by the corn blight organism apparently shows an increase in protein by the decrease in energy value. This means that poultry rations will need to be further supplemented, depending upon the quality of blight-damaged corn that has been used in the ration.

IMPACT ON NATIONAL PRODUCTION LEVELS

Many factors will influence crop production in 1971 and livestock production during the next several years. Crop production in 1971 will be affected by such things as weather, expected corn blight developments, distribution of available blight-resistant seed, Government farm programs, and expected price levels. The outlook for livestock reflects such things as the present stage in livestock production cycles, the level of prices, and livestock-feed-price relationships. It is difficult to evaluate the effects of all factors. However, the following is designed to provide some insight, under given assumptions, as to what might develop for selected major crop and livestock enterprises in the next 1 to 3 years.

Increased flexibility provided in the Agricultural Act of 1970 adds to the complexity of analyzing crop developments in 1971.

CROP PROSPECTS UNDER FOUR ALTERNATIVE SETS OF CONDITIONS WHICH FARMERS MAY ASSUME FOR THE 1971 CROP YEAR¹

Four sets of alternatives used in developing production estimates of corn and other major crops in 1971 are listed in table 3.

Another significant factor for 1971 is how the cropland freed from the diverted acres of the 1970 feed grain program will be used. Should there be no set-aside requirement for 1971, about 37 million acres which were diverted from feed grains during 1970 would be available. Even with a 20-percent required set-aside, an estimated 20 million acres will be available for production in 1971 which were not available during 1970. It may normally be anticipated that much of this land would go into corn production; however, due to the smaller supply of seed corn for 1971 and the danger of blight, this may not occur. Farmers' expected price relationships, primarily between corn and soybeans, and extent of corn blight damage will be the major determinants in their willingness to assume the risk of planting non-blight-resistant seed.

¹ These assumptions and conditions and the resulting analysis of aggregate production were developed prior to the January 1971 planting intentions survey.

Table 3.—ASSUMPTIONS FOR ANALYZING 1971 POTENTIAL U.S. CROP PRODUCTION

Factors	Alternatives ¹			
	1	2	3	4
Farmer's expected yield reductions (percent): ²				
Corn—N-cytoplasm....	0	0	0	0
Corn—T-cytoplasm....	40	40	20	20
Corn—blend.....	20	20	10	10
Corn—F ₂	30	30	30	30
Feed grain program: ³				
Set-aside percentage....	0	20	0	20
Support payment (corn)	0	\$0.32	0	\$0.32
Loan rate (corn).....	\$1.05	\$1.05	\$1.05	\$1.05
Farmer's expected prices:				
Corn (per bushel).....	\$1.50	\$1.50	\$1.30	\$1.30
Wheat.....	\$1.50	\$1.50	\$1.40	\$1.40
Soybeans.....	\$2.60	\$3.00	\$2.60	\$3.00
Cotton (per pound)....	\$0.195	\$0.195	\$0.195	\$0.195

¹ For all of the alternatives, the wheat and cotton set-asides are assumed to be 75 percent and 20 percent, respectively, and payments as established in legislation.

² In areas where blight occurred to cause economic damage in 1970.

³ Substitution between wheat and feed grains was assumed to be a provision of the program, but substitution of soybeans on feed grain base to maintain history was not allowed.

The late announcement of the 1971 farm program resulted in no increase in fall wheat seeding. However, increased flexibility of the program is expected to result in a large increase in acreage planted to spring wheat. Also, sorghum acreage in 1971 is expected to increase because of no specific acreage limitation after meeting set-aside requirements and greater demand due to higher corn prices. The 1970 drought condition in the western Corn Belt and the expected decrease in acres diverted from production as compared to 1970 also are expected to increase sorghum acreage next year.

A major factor affecting alternatives is the level of possible corn blight damage in 1971. Two levels are considered in analyzing results for next year in areas where blight was severe enough to cause economic damage in 1970. Alternatives 1 and 2 assume a more severe yield reduction from blight than do al-

ternatives 3 and 4. Alternatives 1 and 2 were used to reflect farmers expected corn yield reductions from blight of about the same magnitude as occurred in 1970 in affected areas. Naturally, distribution and availability of blight-resistant seed and spread and severity of corn blight in 1971 can significantly affect total production.

Another factor is set-aside requirements of 0 to 20 percent of feed grain base considered for participation in the 1971 feed-grain program. While a 20-percent level has been announced tentatively, some very general interpretation may be made as to possible effects of reductions by interpolating between the 0 and 20 percent levels.

A third major factor influencing farmers' planting decisions next year will be expected levels and relationships of various crop prices. Alternative 1 assumes they expect farm prices for their 1971 crops of \$1.50 for both corn and wheat, and with assumed zero required feed grain set-aside, thereby possibly increasing soybean production, with soybean prices at \$2.60 per bushel. Alternative 2 with a required 20-percent set-aside acreage, assumes farmers' soybean price expectation is increased to \$3 per bushel. Alternatives 3 and 4 assume farmers expect smaller yield reductions from the corn blight and consequently greater production and lower prices for both corn and wheat.

The two factors influencing corn production in 1971 are the acreage and yield (tables 3 and 4). Total cropland acreage can be influenced significantly by the required farm program set-aside. In addition, acreage of specific crops in 1971 will be heavily influenced by farmers' willingness to accept risks of corn blight. Yield is the great uncontrolled variable. For example, with 58 million acres of corn harvested for grain, about the 1970 acreage, yield levels of 85, 75, and 65 bushels per acre would result in total production levels of about 4.9, 4.35, and 3.8 billion bushels. The first 1970 yield estimate on July 1, 1970, was for 83.1 bushels per acre and the final December estimate was 71.7 bushels.

RESULTS OF ANALYSIS.—Total corn production estimates range from 4.1 to 4.3 billion bushels (alternative 2) to a high for alternative 3 of 4.5 to 4.7 billion bushels (table 4). Total corn usage, including exports, was estimated at about 4.7 billion bushels for the 1969-70 marketing year.

Soybean production is likely to expand substantially as a result of the threat of corn blight in 1971, with likely increases under alternative 2 some 100 to 300 million bushels above the 1970 crop to 200 to 400 million bushels larger under the other alternatives.

Soybean use in 1970-71 is expected to expand to approximately 1.3 billion bushels, up slightly from the 1969-70 record level of 1.2 billion bushels. This utilization rate would exceed the 1970 soybean crop by about 15 percent.

Wheat production in 1971 is estimated to increase between zero and 200 million bushels above the 1970 crop with greatest increases in the spring wheat areas. Under all four alternatives, total feed grain production is expected to increase over 1970 because of increases in grain sorghum, barley, and oat production. Marked increases in grain sorghum production are shown for 1971, some 300 to 400 million bushels above the estimated 700-million-bushel 1970 crop. Barley production estimates for 1971 are about 25 percent above the 1970 acreage.

Estimates of oat production under the various alternatives for 1971 are about the same as during 1970. Total feed grain usage (corn, oats, sorghum, and barley) during the 1969-70 marketing year was estimated at about 177 million tons.

Present estimates are for a disappearance of about 173 million tons in the 1970-71 marketing year. Production during 1970 was about 159 million tons.

LIVESTOCK IMPLICATIONS 1971-73

Livestock production this year will be influenced by higher grain prices, but livestock production in 1972 and 1973 will possibly be affected even more by crop and price developments during 1971. Estimated corn prices from the above alternative supply projections were analyzed as to their possible impact on the livestock sector through 1973.

The most immediate impact of the 1970 corn and feed grain situation to the livestock sector has been high feed costs, and consequently, reduced returns to livestock feeders. However, no significant change in volume of marketings resulting from the higher level of feed prices is likely to occur before well into 1971. Both hog and cattle producers likely will market at somewhat lighter weights this winter and spring, and future expansion in hog numbers will be moderated by increased selling of breeding stock.

A normal development of the 1971 crop with prospects for a total crop of 4.3 to 4.7 billion bushels (alternatives 1 and 3) with prices near 1969 or first half 1970 levels would likely result in relatively little impact on the livestock sector. (Note.—This assumes normal cyclical and seasonal patterns already established during the past few years would continue.) Present prospects are for hog slaughter rates to continue high and

above year earlier through mid-1971 and likely will taper off and by fall drop moderately below year earlier levels. Fed-beef production is expected to increase modestly in 1971 and 1972 as the current increasing phase of the beef production cycle continues.

However, should alternatives 2 and 4 develop with smaller feed grain supplies and continued high feed grain prices, then by late 1971 and for the next few years, other developments would be expected to occur in the livestock sector. The most likely development would be a greater liquidation of hog breeding stock than might otherwise occur, particularly during the fall of 1971 and into 1972. Another likely occurrence by 1972 would be an increased rate of culling of beef

breeding stock with resulting increase in nonfed beef production. If this should occur, increases in fed-beef production would be quite limited for the next several years. While there would be no big change occurring in cattle numbers for the next 1 to 3 years, under any of these four alternatives the primary shift would be from fed to nonfed beef production with the possible longer run impact of reducing the potential production of fed-beef for the next several years. Under alternatives 2 and 4, assuming crop production returns to near normal levels in 1972 and thereafter, most effects of a reduced level of corn production and higher prices would be eliminated by 1975.

Table 4.—GRAIN PRODUCTION IN 1970, AND ESTIMATES FOR 1971 UNDER FOUR SETS OF ALTERNATIVES (DECEMBER 1970)

Crop	1970 ¹	Assumptions for 1971 ²			
		1	2	3	4
Corn:					
Planted for grain, million acres.....	58.7	60.9	56.6	59.2	54.4
Production, billion bushels.....	4.1	4.3-4.5	4.1-4.3	4.5-4.7	4.1-4.3
Total feed grains, million tons.....	159	182-188	170-176	186-192	171-177
Wheat production, billion bushels.....	1.4	(All in 1.3-1.5 range)			
Soybean production, billion bushels.....	1.1	1.3-1.5	1.2-1.4	1.3-1.5	1.3-1.5

¹ Dec. 1, 1970, estimates of production.

² See table 3 for details of assumptions.

PLANNING AND DECISIONMAKING BY INDIVIDUALS

CORN BLIGHT UNCERTAINTY AND 1971 DECISIONMAKING

Farm managers face increased uncertainty on corn production for 1971, especially in areas seriously hit by corn blight in 1970. Those in areas not damaged by blight may feel uncertain as to whether blight might damage corn on their farms in 1971.

Blight has been added to the usual uncertainty facing corn growers—prices, weather, and other diseases. There is more uncertainty on price expectations for 1971 corn and other grains because the total of 1971 corn production is more in question than in other years.

Farmers will have to make decisions based on less knowledge than usual. This means greater risk.

They cannot predict the odds on blight damage in 1971. Farmers in blight-susceptible areas need to make the best judgments they can as to the likelihood of blight damage in 1971, particularly to T-cytoplasm corn. Before planting time, they will need to obtain information from many sources about expected blight conditions.

Examples of two farmers' thinking illustrate how they may decide on the expected amount of blight damage if they use T-cytoplasm seed in 1971.

Farmer A figures he had about 20 percent damage on T-cytoplasm corn in 1970. He has gathered information from numerous sources and participated in discussions on the blight situation. He might use the procedure in table 5 to estimate the risk of blight on "T" corn next year:

Table 5.—FARMER A's ANTICIPATION OF
BLIGHT DAMAGE TO "T" CORN IN 1971

	Possible amount of damage (percent)	Estimated probability of occurrence (percent)	Calculation of overall probability (percent)
	10	40	$.10 \times .40 = .04$
	20	40	$.20 \times .40 = .08$
	30	20	$.30 \times .20 = .06$
Total	xxx	100	$= .18$
Overall estimate of probable blight damage (percent) = 18			

Thus, Farmer A would anticipate, on the basis of his current thinking, 18 percent blight damage with "T" seed.

Farmer B had 30 percent damage to his "T" corn

last year. More of his corn ground is lowland than is Farmer A's land. He feels there is a slight chance he could have up to 50 percent damage next year.

Table 6.—FARMER B's ANTICIPATION OF
BLIGHT DAMAGE TO "T" CORN IN 1971

	Possible amount of damage (percent)	Estimated probability of occurrence (percent)	Calculation of overall probability (percent)
	15	10	$.15 \times .10 = .015$
	30	40	$.30 \times .40 = .120$
	40	40	$.40 \times .40 = .160$
	50	10	$.50 \times .10 = .050$
Total	xxx	100	$= .345$
Overall estimate of probable blight damage (percent) = 34.5			

Farmer B expects around 35 percent damage from blight. Both farmers are aware that some varieties of T-cytoplasm seed were more tolerant to blight. If some seed of these varieties is available, they will want to recompute their expected loss and estimate less damage.

The above procedure could be used by any farmer who feels threatened by corn blight in 1971 by substituting his estimates of damage levels and probability of occurrence in the same format.

Farmers A and B may want to make a similar analysis of the uncertainty of price expectations for the 1971 corn crop. Farmer A is more optimistic than Farmer B. He expects less blight damage on his farm and a larger total crop nationally. Shown below are calculations Farmers A and B may use to estimate corn prices in October 1971.

Table 7.—FARMER A's ANTICIPATION OF
CORN PRICE IN OCTOBER 1971

	Possible price level	Estimated probability of occurrence (percent)	Calculation of overall probability (percent)
	\$1. 10	20	$\$1.10 \times .2 = \0.22
	1. 30	40	$1.30 \times .4 = .52$
	1. 50	30	$1.50 \times .3 = .45$
	1. 60	10	$1.60 \times .1 = .16$
Total	xxxx	100	
Overall estimate of probable corn price per bushel = \$1.35			

Table 8.—FARMER B's ANTICIPATION OF
CORN PRICE IN OCTOBER 1971

Possible price level	Estimated probability of occurrence (percent)	Calculation of overall probability (percent)
\$1. 10	10	$\$1.10 \times .1 = \0.11
1. 30	10	$1.30 \times .1 = .13$
1. 50	40	$1.50 \times .4 = .60$
1. 60	30	$1.60 \times .3 = .48$
1. 70	10	$1.70 \times .1 = .17$
Total	xxxx	100
Overall estimate of probable corn price per bushel = \$1.49		

Farmers with different views on price probability could use this same procedure to arrive at price estimates for the 1971 corn crop.

These techniques will help the farmer to consider crop alternatives as discussed in an earlier section, and also aid him in developing a complete farm operating plan for 1971.

HEDGING.—Farmers A and B are aware that they can hedge their 1971 corn production on the futures market. Assuming these farmers think they could realize about \$1.45 per bushel from a futures contract, they would face still further risk considerations. In order to realize the \$1.45 per bushel with a high degree of certainty, each farmer must actually produce the amount of corn he sells on the futures market. Also, he would have to sell the corn at the same time he closed out his futures contract. To the extent he does not sell as much corn as he has in a futures contract and does not sell at the same time he closes out the contract, he becomes a speculator on corn prices.

If a farmer locks in his crop at \$1.45, he incurs the added risk of not benefiting from any higher price at harvest or later. Since Farmer A thinks \$1.35 per bushel is most probable and he does not see much chance of corn prices rising much above \$1.45, he may seriously consider entering the futures market. This means that he would have to tie up some funds to hold a contract until the fall of 1971.

Farmer B's expectation of \$1.49 per bushel, together with his belief that there is only a 40 percent chance of prices being above \$1.50 per bushel, may lead him to have no serious interest in the futures market at this time.

PLANNING TECHNIQUES

A corn grower faces chances in 1971, both of heavy losses and unusually high returns per acre. He can farm in 1971, incurring practically no danger of blight. But if he does he probably will sacrifice hope of some amount of income . . . possibly a great deal.

He can avoid the chance of corn blight by planting no corn. He can reduce the chance of blight damage to his corn crop to very little by planting only first-generation seed corn of locally adapted high-yielding hybrid varieties that withstood the blight well in 1970. The trouble with this, of course, is that there is not enough such seed corn to go around. If he has enough seed corn that meets these standards to plant all of the crop he wishes to plant, or if he can get enough at a price he can afford, he need read no further.

If this is not the case, he has some choices to make. His choices center on what he will do with corn land for which he cannot get enough of the seed described above. His four main categories of choices:

- Plant less desirable seed corn.
- Plant crops other than corn.
- Participate in the feed grain program.
- Stretch best seed corn over more acres.

A farmer would like to know which of these—or rather, what combination of them—will be most profitable in 1971. Unfortunately, it is not possible to know that. No one knows where in the major corn-producing areas of the United States the blight will attack susceptible corn if it is planted in 1971. Nor can anyone be certain about how early in the corn-growing season it will strike susceptible corn, nor with how much virulence.

He may want to assume two or more possibilities in 1971 (as to blight damage) and formulate possible courses of action appropriate for each before he decides what to do. He may want to assume different prices for corn in the fall of 1971.

In any event, he will want to look at possibilities for profits and losses from growing corn and other crops in the uncertain circumstances of the spring of 1971, and make some judgments as to the likelihood of each and how it would affect this net income. The suggested steps that follow are offered as a help in doing that and in choosing the course of action that seems best. These steps are:

- Make some general judgments as to chances of blight damage and prices of corn next fall.

Take stock of resources, particularly corn land and seed corn that he has or can get.

Consider how to make the best use of his best seed corn.

Estimate returns from growing corn in 1971 under the most important possibilities (in step 1) as to blight damage and price of 1971-crop corn.

Put the results of these estimates in a framework; compare them and study their meaning.

Consider alternatives other than growing corn for part of the corn land (or maybe even for most of it—or all of it—if these alternatives seem better than growing corn).

Decide what chances of loss he is willing and able to accept in return for the hopes of profit that come with them.

Now, having eliminated a good many alternatives, work out a plan, using only the best ones that remain.

Following is an illustration of how a farmer might do these things:

Farmer B, whose judgments are compared above with those of Farmer A, thinks that the blight will likely reduce yields of susceptible corn in his locality

by 15 to 50 percent in 1971—most likely 35 percent, he thinks. He thinks the price of corn in the fall of 1971 will be \$1.10 to \$1.70—most likely \$1.50.

Suppose Mr. B has been able to buy 500 pounds of first-generation seed of a high-yielding hybrid corn, well adapted to his land and climate, that withstood the blight well in 1970. This hybrid variety was produced with “N” cytoplasm. It was produced by detasseling. Suppose Mr. B was also able to buy, in addition, 500 pounds of seed of this same hybrid variety which is a blend—half of it produced with “N” cytoplasm and half with “T” cytoplasm. The seed produced with “T” cytoplasm was damaged by blight in 1970. Mr. B paid 50 cents per pound for this blended seed. At 40 cents per pound Mr. B can buy all he needs of seed of this same hybrid produced altogether with “T” cytoplasm (“T” seed).

Mr. B’s corn land, 180 acres of it, is practically uniform in its corn-yielding capacity.

The University of Missouri conducted an experiment, over the 4-year period 1965–68, that might be useful to Farmer B. Several other State land-grant universities have conducted similar experiments on different kinds of land and in different climates. Table 9 is based on this Missouri experiment.

Table 9.—SEED, NITROGEN, YIELDS, COSTS, AND RETURNS PER ACRE*

Seed corn planted		Nitrogen applied		Yield		Return above variable cost ⁴
Pounds	Cost ¹	Pounds	Cost ²	Bushels	Value ³	
7	\$5.04	0	0	90	\$126	\$86
9	6.48	0	0	72	101	60
11	7.92	0	0	57	80	37
7	5.04	50	\$2.50	110	154	111
9	6.48	50	2.50	119	167	123
11	7.92	50	2.50	110	154	109
7	5.04	100	5.00	118	165	120
9	6.48	100	5.00	128	179	133
11	7.92	100	5.00	132	185	137
13	9.36	100	5.00	132	185	136
9	6.48	150	7.50	128	179	130
11	7.92	150	7.50	135	189	139
13	9.36	150	7.50	135	189	137
11	7.92	200	10.00	130	182	129
13	9.36	200	10.00	133	186	132

*The nonprice data are based on “Bradford Farm Agronomy Field Day”, June 10, 1969. Agricultural Experiment Station University of Missouri.

¹ At 72 cents per pound.

² At 5 cents per pound.

³ At \$1.40 per bushel just before harvest. Cost of harvesting and drying are estimated at 10 cents per bushel. This is equivalent therefore to \$1.50, the price Mr. B thinks most likely.

⁴ Value of corn less cost of seed and nitrogen and \$35 of other variable costs per acre.

Let’s suppose that Mr. B can expect yields on his corn land like those in table 9, but only on that portion of his corn land that he plants with his “N” seed.

(With his blend seed or “T” seed or any other seed corn he can get, he will have to expect lower or uncertain yields.)

From table 9, Mr. B can see that he can get the most *per acre* by planting 11 pounds of seed per acre and applying 150 pounds of nitrogen to the corn crop. But since he has only enough "N" seed to plant 45

acres at the rate of 11 pounds per acre, he must consider how to get the most out of it. He constructs table 10.

Table 10.—RETURNS PER BAG OF SEED CORN

Seed per acre, pounds	Acres planted per 50-pound bag seed	Per acre			Return above variable costs per bag of seed
		Nitrogen, pounds	Yield, bushels	Return above variable costs	
“N” seed					
7	7.1	100	118	\$120	\$852
9	5.6	100	128	133	745
11	4.5	150	135	139	626
13	3.8	150	135	137	521
Blend seed if blight reduces yield of susceptible “T” seed by 35 percent, as Mr. B thinks most likely. (The blend will be reduced 17.5 percent.)					
7	7.1	100	97	\$92	\$653
9	5.6	100	106	102	572
11	4.5	150	111	105	473

Table 10 tells Mr. B that he can get a higher return per bag of seed corn by planting it thinner, on more acres. The two tables together (tables 9 and 10) *do not* tell him *how much thinner* would be most profitable. He reasons that the best answer depends on what

he can expect from the other seed he can get. He prepares budgets similar to those above in this publication for the degrees of blight damage and prices of corn that he thinks likely. He summarizes them in table 11.

Table 11.—EXPECTED RETURNS PER ACRE ABOVE VARIABLE COSTS

Possible yield reduction by blight of corn planted to "T" seed (percent)	Possible price of corn	Seed corn planted				
		"N"		Blend		"T"
		7 pounds	9 pounds	7 pounds	9 pounds	11 pounds
15	\$1.00	\$73	\$82	\$67	\$73	\$68
	1.40	120	133	111	120	114
	1.60	144	160	133	141	137
35	1.20	97	108	73	82	59
	1.40	120	133	92	103	77
	1.60	144	160	111	124	94
50	1.40	120	133	39	45	33
	1.60	144	160	51	58	47

Table 11 tells Mr. B that under some of the conditions he thinks possible, his dollar returns per acre from growing corn with "T" or blend seed would be very low. This causes him to think about other possibilities.

Mr. B figures that his return per acre above vari-

able costs for participation in the Feed Grain program will be \$108 set-aside, or \$3,888 for 36 acres. He estimates his returns from growing soybeans on his corn land at \$55 per acre above variable costs. With these figures, and by using table 11, he develops table 12.

Table 12.—ALTERNATIVES AND EXPECTATIONS

Yield reduction (1), price of corn (2), and possible planting plan	Pounds of seed corn per acre	Acres	Returns above variable costs	
			Per acre	Total
15 percent—\$1.40:				
No. 1 "N" seed	9	56	133	\$7, 448
Blend seed	9	56	120	6, 720
Set-aside		36	108	3, 888
"T" seed	11	32	114	3, 648
Total		180		21, 704
35 percent—\$1.40:				
No. 2 "N" seed	7	71	120	8, 521
Blend seed	7	71	92	6, 532
Set-aside		36	108	3, 888
"T" seed	11	2	77	154
Total		180		19, 095
50 percent—\$1.40:				
No. 3 "N" seed	7	71	120	8, 520
Set-aside		36	108	3, 888
Soybeans		73	55	3, 960
Total		180		16, 368
No. 1 (above)				14, 912
No. 2 (above)				15, 244

Table 12 presents three possible planting plans. The second seems a good one for the conditions Mr. B thinks most likely. Under different conditions, as to blight damage and price of corn, other plans would be better. There are many possibilities in addition to

those shown in table 12. To arrive at the plan Mr. B thinks best for him, he probably will need to do a great deal more figuring similar to that in table 12. Especially, he needs to work out plans for *higher and lower* prices for corn than \$1.40 per bushel.

